



Volume 3

Chapter 8 Tulare Lake Hydrologic Region

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Contents

Chapter 8 Tulare Lake Hydrologic Region.....	8-1
Setting.....	8-1
Climate.....	8-1
Population	8-2
Land Use	8-3
Water Supply and Use.....	8-4
Water Recycling	8-6
State of the Region	8-8
Challenges	8-8
Accomplishments	8-10
Relationship with Other Regions	8-13
Looking to the Future	8-13
Regional Planning	8-13
Water Portfolios for Water Years 1998, 2000, and 2001	8-15
Water Year 1998	8-15
Water Year 2000	8-17
Water Year 2001	8-18
Selected References	8-19

Box

Box 8-1 Ongoing Planning	8-14
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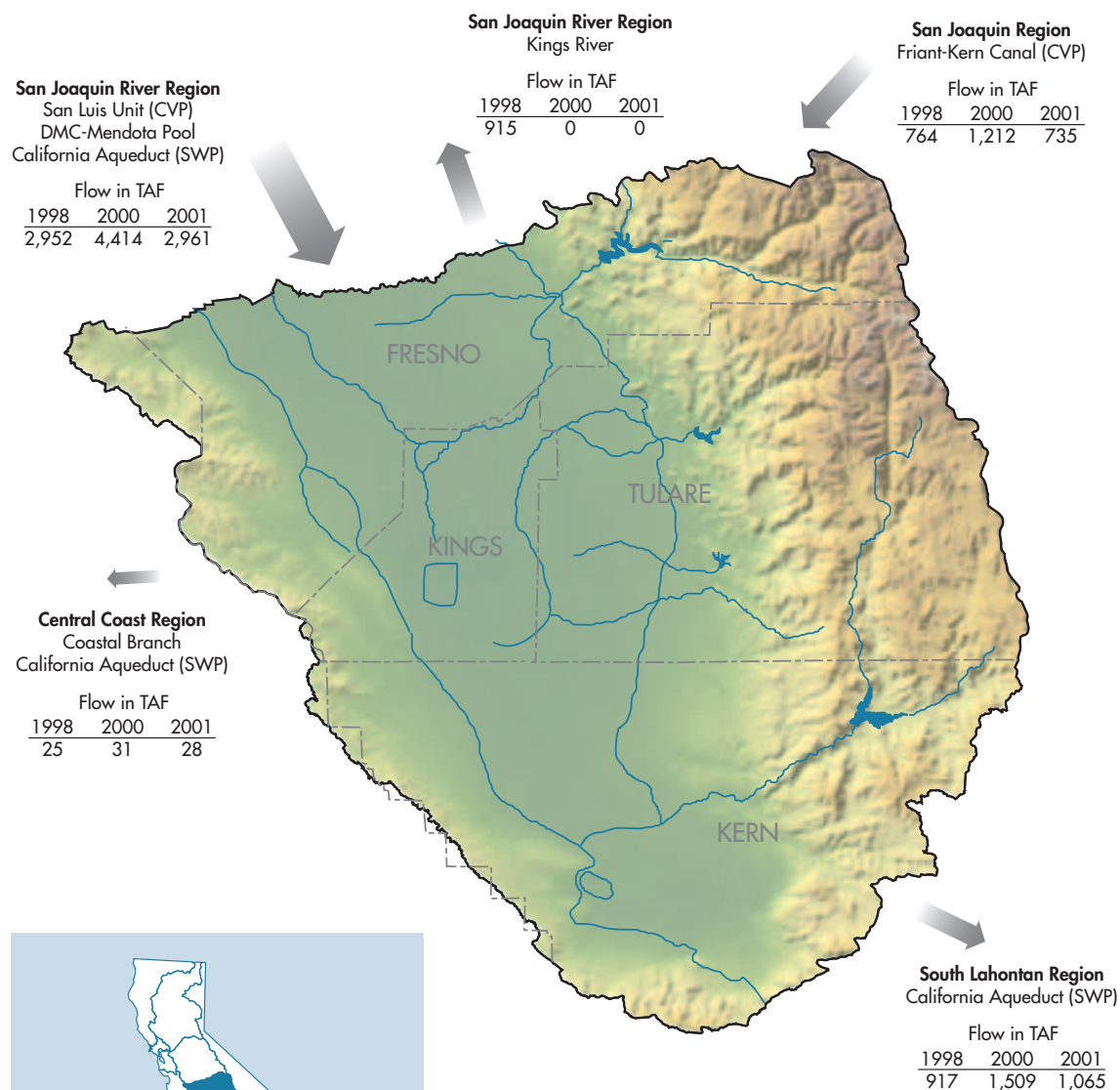
Figures

Figure 8-1 Tulare Lake Hydrologic Region (map).....	8-ii
Figure 8-2 Tulare Lake Hydrologic Region population.....	8-3
Figure 8-3 Tulare Lake region water balance for water years 1998, 2000, and 2001 (2 bar charts).....	8-5
Figure 8-4 Tulare Lake region - illustrated water flow diagram	8-23
Figure 8-5 Tulare Lake region - schematic flow diagram	8-24

Tables

Table 8-1 Tulare Lake Hydrologic Region water balance summary.....	8-7
Table 8-2 Percentage of acreage of each crop category by irrigation method used – Kern County.....	8-11
Table 8-3 Tulare Lake Hydrologic Region water use and distribution of dedicated supplies	8-16
Table 8-4 Tulare Lake region water portfolios.....	8-22

Figure 8-1 Tulare Lake Hydrologic Region



Some Statistics

- . Area - 17,033 square miles (10.7% of State)
- . Average annual precipitation - 15.2 inches
- . Year 2000 population - 1,884,675
- . 2030 population projection - 3,121,625
- . Total reservoir storage capacity - 2,046 TAF
- . 2000 irrigated crop area - 3,219,000 acres

The Tulare Lake Hydrologic Region is in the southern end of the Central Valley and is one of the nation's leading areas in agricultural production. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 8 *Tulare Lake Hydrologic Region*

Setting

The Tulare Lake Hydrologic Region is in the southern end of the San Joaquin Valley. This region includes all of Tulare and Kings counties and large portions of Fresno and Kern counties. Major cities include Fresno, Bakersfield, and Visalia. The Tulare Lake region is one of the nation's leading areas in agricultural production with a wide variety of crops on about 3 million acres. Agricultural production has been a mainstay of the region since the late-1800s, and gross farm production receipts from the region account for 35 percent of the state's total agricultural economy. This region's population is also growing rapidly, and population growth rates began increasing above historical trends in the 1980s. As property values in the metropolitan coastal areas have become less affordable, many people began relocating to more affordable areas in the San Joaquin Valley. This trend has accelerated in recent years, and the California Department of Finance reported the Tulare Lake regional population at 2 million in 2001.

Native habitat in the region includes vernal pools, areas of valley sink scrub and saltbush, freshwater marsh, grasslands, arid plains, and oak savannah. The growth of agriculture in the Tulare Lake region has replaced much of the historic native grassland, woodland, and wetland.

A map of this region with a table of statistics are presented in Figure 8-1. The largest river is the Kings River, which flows west from the Sierra Nevada near the northern border of the region. The California Aqueduct extends the entire length of the west side of the region, delivering water to State Water Project (SWP) and Central Valley Project (CVP) contractors in the region and exporting water over the Tehachapi Mountains to Southern California. Significant rivers in the region include the Kings, Kaweah, Tule and Kern rivers, which drain into the valley floor of this hydrologically closed region. The Kings and Tule rivers historically terminated at the Tulare Lake, which was once the largest freshwater lake in the western United States. The Kern River historically terminated in two small lakes, Kern

Lake and Buena Vista Lake. These lakes have been dry for many decades, and the waters that once fed them were long ago diverted for irrigation, such that the lake bottom lands are now heavily farmed. No significant rivers or creeks drain eastward from the Coast Ranges into the valley.

Climate

Land in the region is fertile and well suited for farming. The valley portion of the region is hot and dry in summer with long, sunny days and cooler nights. Winters are wet and often blanketed with dense fog. Nearly all of the annual rainfall occurs in the six months from November to April. The valley is broad and flat, and is surrounded by the Diablo and Coast Ranges to the west, the Sierra Nevada to the east, and the Tehachapi Mountains to the south. The surrounding mountains result in the comparative isolation of the region from marine effects. Because of this and the comparatively cloudless summers, average maximum temperatures approach a high of 101 degrees in late July. Winter temperatures on the valley floor are usually mild, but during infrequent cold spells readings occasionally drop below freezing. Heavy frost occurs during the winter of most years, and the geographic orientation of the valley generates prevailing winds from the northwest.

The mean annual precipitation in the valley portion of this region ranges from about 6 to 11 inches, with the lowest amounts near the south and eastern ends of the region. Sixty-seven percent of the precipitation occurs during the months of December through March, and 95 percent of all precipitation falls during the October through April period. The Tulare Lake region enjoys a high percentage of clear sunny days during most of the year, except during the winter months of November, December, January, and February. During periods of tule fog, which can last up to two weeks, sunshine is reduced to a minimum. This fog frequently extends to a few hundred feet above the surface of the valley and presents the appearance of a heavy, solid cloud layer. These prolonged periods of fog and low temperatures are important to orchard production for the deciduous fruit industry.

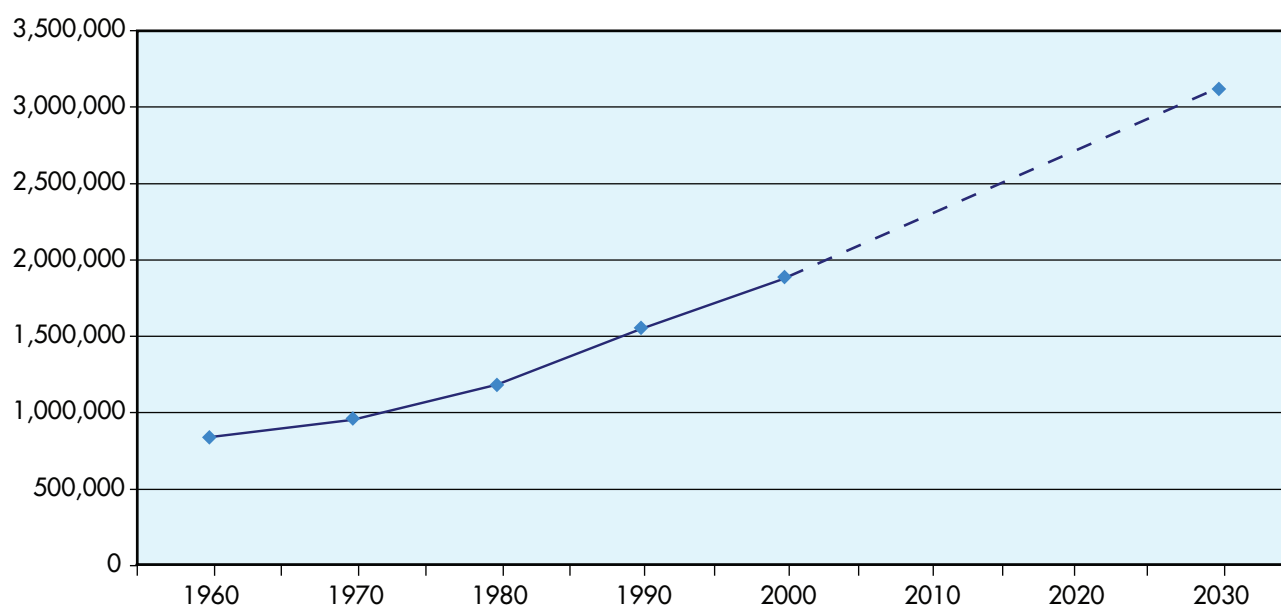


The Tulare Lake region is one of the nation's leading areas in agricultural production with a wide variety of crops on about 3 million acres. This is an unusual photo of Tulare Lake, which is normally dry. (DWR photo)

Population

The rate of population growth throughout the San Joaquin Valley is among the highest in the state, creating a strong demand for housing and urban infrastructure. The population in the Tulare Lake Region is now about 52 percent of the entire San Joaquin Valley population. While many communities in the region welcome the growth and income from a diversifying economy, the rapid urban growth is beginning to generate impacts on farming and the agricultural industry. In six years, between 1992 and 1998, nearly 37,000 acres of farmland were converted to urban uses according to Department of Conservation statistics. Even though there is a concern about accelerated urbanization and the subsequent conversion of farmland, relatively few private agricultural preservation efforts exist in the San Joaquin Valley. The largest regional population centers are the Fresno/Clovis metropolitan area and the cities of Bakersfield and Visalia. Other smaller population centers include the cities of Tulare, Hanford, Porterville, and Delano.

Household incomes and housing prices in the Tulare Lake region are lower on an average basis, compared to other regions of the state. New jobs in services, industries, construction, and agriculture are generally low-skilled and low-wage jobs, subject to seasonal fluctuation. As a result, unemployment consistently exceeds the state and national rates by as much as 10 percent. According to an April 2004 Public Policy Institute of California (PPIC) special survey, the most pressing San Joaquin Valley issues for residents of the South San Joaquin survey area were related to population growth and development. These issues included pollution, 32 percent; healthy economy, 13 percent; population growth, 11 percent; crime, 9 percent; and adequate water at 6 percent. The most notable trend of annual PPIC surveys is the increasing amount of concern about air pollution and all pollution in general. In 1999, pollution was cited by 9 percent of the survey respondents as the most important issue, 13 percent in 2001, 19 percent in 2002, 28 percent in 2003, and 32 percent in 2004.

Figure 8-2 Tulare Lake Hydrologic Region population

Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for the Tulare Lake region.

Population density varies widely on a county-by-county basis, and large portions of some counties are virtually unpopulated. Much of the population lives in the more densely developed cities and towns. The population in the Tulare Lake region was about 1.55 million people in 1990 and reached 1.88 million by 2000. This is more than a 20 percent growth rate over that 10-year period. Statewide, California experienced a population increase approaching 14 percent from 1990 to 2000. Between 1998 and 2000, the population increased more than 3 percent, and California Department of Finance statistics project continued growth rates of 18 percent to 22 percent for the region's four counties over the next 10 years. Figure 8-2 shows the Tulare Lake region's population from 1960 through 2000, with projections to year 2030.

Land Use

The State and federal government agencies own about 30 percent of the land in the region, including about 1.7 million acres of national forest, 0.8 million acres of national parks and recreation areas, and 1 million acres of land managed by the U.S. Bureau of Land Management. The region's foothills border Kings Canyon and Sequoia National Parks and the Sierra National Forest. Privately owned land totals about 7.4

million acres. Irrigated agriculture accounts for more than 3 million acres of the private land, while urban areas take up over 350,000 acres. Other agricultural lands and areas with native vegetation represent an additional 1.4 million acres in the region.

The climate and soils of the Tulare Lake region contribute significantly to the tremendous agricultural production of the farm lands and to the diversity of crops grown. Counties in the Tulare Lake region represent three of the top five agricultural counties in the state, as measured by total value of production. More than 250 varieties of crops and farm commodities are produced in the region. While cotton was the number one crop in many past years, grapes have recently outpaced cotton in terms of gross production receipts. More than 10 percent of the irrigated acreage in California and about 12 percent of the 3 million irrigated acres in the region is planted in alfalfa. Alfalfa acreage in the region has been rising in recent years in response to the needs of the expanding dairy industry. Tulare County, in the heart of the region, is currently the nation's richest dairy county. Deciduous and citrus trees are the main agricultural crops in the lower foothills, and livestock grazing and timber harvesting occur in the higher elevation areas.

The Central Valley constitutes less than 1 percent of the United States farmland but produces 8 percent of the total agricultural output. Further, while more than 12 percent of the national gross receipts for farming came from California's agriculture, more than 4 percent of these came from the Tulare Lake region alone. According to the California Department of Agriculture, total statewide agricultural production and gross cash income in 1998 declined 6 percent from 1997, and statewide gross income in 2001 increased 1 percent from 2000. By comparison, agricultural production and cash income in the Tulare Lake region declined to \$9.1 billion from 1997 to 1998, which was only a 3.7 percent decrease. Between 2000 and 2001, the Tulare Lake regions agricultural production increased by 3.4 percent to \$9.9 billion.

Some of the crops and farm commodities that are produced in the Tulare Lake region experienced dramatic increases in export value in 2001. Table grapes, milk and cream, and walnuts all showed double-digit percentage increases in export value from 1998. However, most farm commodities experienced declines in export values between 1998 and 2001. Seven of the top 10 exported crops or commodities declined in value. These included almonds, \$760 million to \$686 million; cotton, \$734 million to \$605 million; and wine, \$506 million to \$491 million. These increases and decreases within the agricultural industry dominate the economy of these four counties and the region as a whole.

Water Supply and Use

The region receives most of its surface water runoff from four main rivers that flow out of the Sierra Nevada, which are the Kings, Kaweah, Tule, and Kern rivers. The development and use of water from these rivers has played a major role in the history and economic development of the region. Major water conveyance facilities in the region include the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal. Water diversions from the San Joaquin River at Friant Dam are also a significant supply source for all uses in the Tulare Lake region. The water districts in the region have developed an extensive network of canals, channels, and pipelines to deliver water supplies to customers. Water storage facilities and conveyance systems control and retain most of the surface water runoff from the watersheds in the region, except in extremely wet years when floodwaters may flow out of the region to the San Joaquin River. During flood years, excess water flows down the north fork of the Kings River toward Mendota Pool and on to the San Joaquin River. In the wettest years, Kings River floodwaters reach the normally dry Tulare Lake via the south fork of the river. Excess runoff from the Kaweah and Tule

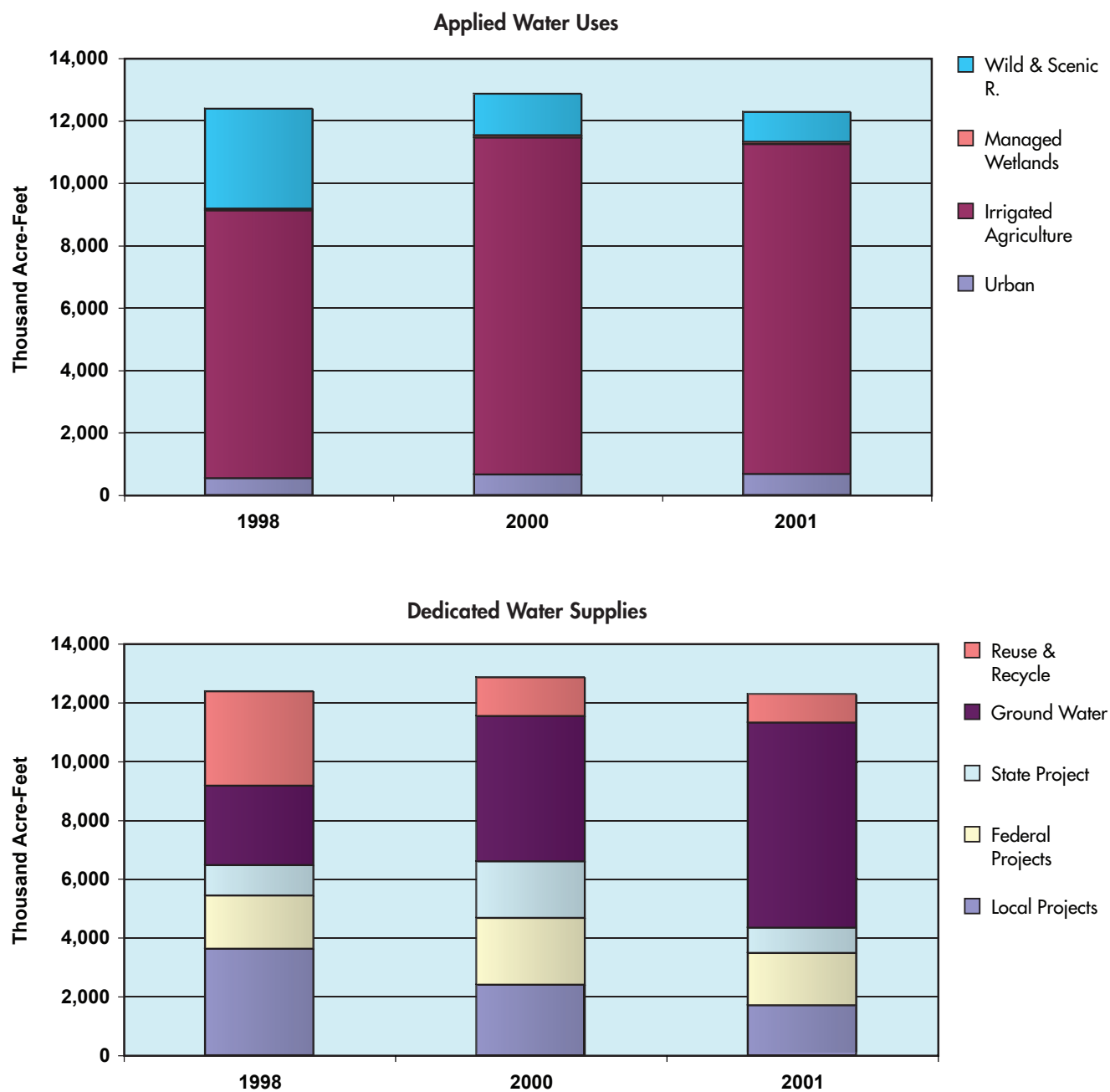
rivers might also flow into Tulare lakebed, flooding low-lying agricultural fields. This excess surface water is managed to the maximum extent for use in artificial groundwater recharge. In the rare event water leaves the basin, it is because the absorptive capacity of the groundwater systems in the region has been exceeded. Floodwater can also occasionally be diverted from the Kern River intertie into the California Aqueduct for use in other SWP service areas. Figure 8-3 graphically summarizes the water supplies and the developed water uses in the region for 1998, 2000, and 2001.

Water stored in many Sierra Nevada reservoirs is also used to generate electricity as it is released downstream. Some diversions occur for consumptive use in local communities, but most flows are recaptured in larger reservoirs in the foothills and along the eastern edge of the valley. These larger reservoirs were built primarily for flood control, but many of them were also designed with additional storage capacity for agricultural, urban, and fishery purposes. Smaller communities in the Sierra foothills receive their water from smaller local surface supplies and groundwater. These mountain communities sometimes pump groundwater from hard rock wells and old mines to augment their supplies, especially during droughts. Groundwater is the only source available for many foothill and mountain residents who are not connected to a municipal water system.

Major statewide water projects in the Tulare Lake region include the SWP's California Aqueduct, which includes a State/federal joint use segment known as the San Luis Canal. The aqueduct is along the western side of the valley, and it also pumps water over the Tehachapi Mountains for uses in Southern California. Water from the Sacramento-San Joaquin Delta is imported into the region through the California Aqueduct for both agricultural and urban purposes. Federal CVP water is also exported from the Delta through the San Luis Canal to agencies with federal water contracts on the west side of the valley, such as Westlands Water District. On the eastern side of the valley, the CVP's Friant-Kern Canal runs south along the foothills and transports San Joaquin River water to agencies along the valley's eastern side and extends into Kern County.

The SWP provides an average of 1.2 million acre-feet of surface water annually to the region for both agricultural and urban purposes. The U.S. Bureau of Reclamation supplies an average of 2.7 million acre-feet from the CVP through the Mendota Pool, the San Luis Canal, and the Friant-Kern Canal, primarily for agricultural uses. Actual deliveries to contrac-

Figure 8-3 Tulare Lake region water balance for water years 1998, 2000, 2001



Three years show a marked change in the amount and relative proportions of water delivered to Tulare Lake region's urban and agricultural sectors and water dedicated to the environment (applied water, top chart), where the water came from, and how much water was reused among sectors (dedicated water supplies, bottom chart).

tors vary from year to year based upon a number of factors, including water supply conditions and reservoir storage in Northern California. Other factors that may influence imported surface water deliveries include pumping equipment malfunction, natural disasters, temporary closures for infrastructure development, and environmental challenges.

Groundwater has historically been important for both urban and agricultural uses in the Tulare Lake region. Groundwater pumped from the basin's aquifers account for about 33 percent of the region's total annual water supply, and also account for 35 percent of all groundwater use in the state. Additionally, the region's groundwater supply represents about 10 percent of the state's overall developed water supply for agricultural and urban uses. Most towns and cities along the east side of the valley, including Fresno, Visalia and Bakersfield, rely primarily on groundwater. Bakersfield occasionally obtains supplemental water from local surface water and some imported SWP water. Fresno, Visalia, Bakersfield, and other cities also have groundwater recharge programs to help ensure that groundwater will continue to be a viable water supply in the future. On the valley's western side, smaller cities like Avenal, Huron, and Coalinga rely on imported surface water from the San Luis Canal to meet municipal demands. This surface water is of better quality than the local groundwater supplies on the western side, which often have poor water quality.

In addition to the recharge programs employed by some valley cities, extensive groundwater recharge programs (known as water banks) are also operated by water districts and agencies, which have stored significant amounts of surplus water underground for future use and exchanges through water banking programs. For more than 100 years, water users throughout the region have used conjunctive use to maximize the water supply and maintain the groundwater basins.

Table 8-1 presents a water balance summary of all water supplies and uses for the Tulare Lake region. Table 8-3 presents actual data for the dedicated and developed urban, agricultural and environmental water uses in the region for 1998, 2000, and 2001. A comparison of regional urban, agricultural and environmental water uses indicates that urban water use is about 5 percent of total uses, agricultural water use averages 84 percent and environmental water use is normally about 11 percent of the developed water supplies.

As surface water was developed and imported water became available, water districts were organized to fund water conveyance and delivery infrastructure to serve the area's develop-

ing agriculture. Many different crops are grown throughout the region. Most of the agricultural land in the region lies in organized water districts. Many water districts in recent years have actively been changing water management practices and physical structures to improve the efficiency of water delivery and use.

Urban water use accounts for about 5 percent of the total applied water in the Tulare Lake region. Until recently, many of the communities in the region have not used water meters, and customers are charged a flat rate for water use. However, urban communities are gradually working toward the installation of water meters as funding allows. State legislation, AB 514 (Kehoe), signed into law in October 2003, requires all California cities that receive water from the CVP to install and use water meters by year 2013. Some of the larger cities that are affected include Sacramento, Folsom and Fresno. In Fresno, the new law is being viewed as a solution to a long-standing problem. It is believed that AB 514 will remove the requirement for Fresno to obtain voter approval to amend its charter to permit metering of water. The U.S. Bureau of Reclamation and the federal Department of Interior have made the installation of water meters a requirement if Fresno plans to renew its CVP contract for 60,000 acre-feet of surface water from the Friant Division.

The variability of industrial water use is a function of economic, climate, and technological factors. Agriculture harvest schedules have a large effect because significant amounts of water are used for processing harvested crops. Local water agencies supply water to most of the smaller industrial facilities in the cities. However, larger industrial and institutional water users both inside and outside urban areas generally develop their own groundwater supplies or divert from local surface water sources. Higher per capita water use in areas like Fresno and Bakersfield are generally due to their higher concentration of these industries. In the case of Bakersfield, the food processing and oil industries have historically been a large segment of the total industrial water use activity.

Water Recycling

In the Tulare Lake region, discharge of recycled water is regulated through the Central Valley Regional Water Resources Control Board, as described in the Board's Tulare Lake Basin Plan. The significant increase in population in the Tulare Lake region has resulted in a rising volume of recyclable water. This has forced municipalities to reassess collection, transmission, and treatment capacities of their wastewater plants to handle

Table 8-1 Tulare Lake Hydrologic Region Water Balance Summary - TAF

Water Entering the Region – Water Leaving the Region = Storage Changes in Region

Water Year (Percent of Normal Precipitation)			
	1998 (207%)	2000 (93%)	2001 (85%)
Water Entering the Region			
Precipitation	27,306	12,693	11,564
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	3,716	5,627	3,696
Total	31,022	18,320	15,260
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	5,401	7,427	7,591
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	1,857	1,540	1,093
Statutory Required Outflow to Salt Sink	0	0	0
Additional Outflow to Salt Sink	457	457	458
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	22,606	10,578	10,374
Total	30,321	20,002	19,516
Storage Changes in the Region			
[+] Water added to storage			
[-] Water removed from storage			
Change in Surface Reservoir Storage	438	-57	-141
Change in Groundwater Storage **	263	-1,625	-4,115
Total	701	-1,682	-4,256
Applied Water * (compare with Consumptive Use)	8,429	10,717	10,717

***Footnote for applied water**

Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

****Footnote for change in Groundwater Storage**

Change in Groundwater Storage is based upon best available information. Basins in the north part of the state (North Coast, San Francisco, Sacramento River and North Lahontan regions and parts of Central Coast and San Joaquin River regions) have been modeled – spring 1997 to spring 1998 for the 1998 water year and spring 1999 to spring 2000 for the 2000 water year. All other regions and year 2001 were calculated using the following equation:

$$\text{GW change in storage} = \text{intentional recharge} + \text{deep percolation of applied water} + \text{conveyance deep percolation} - \text{withdrawals}$$

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow.

increasing volumes. Most of the recycled water in the region is used for irrigation and groundwater recharge. The rest is evaporated. There are several cities, such as Bakersfield, that built recycled water delivery systems for agricultural irrigation use. When effluent is discharged, a discharge permit must be obtained as part of the EPA National Pollutant Discharge Elimination System (NPDES) Permitting Program. Water reuse in the Tulare Lake region was estimated to be over 150,000 acre-feet in 2000. Groundwater recharge programs account for more than half of all recycled water use.

State of the Region Challenges

Whenever a region looks outside of its borders for more water, statewide water management and integrated resource planning become important considerations. Depending on the package of options chosen, one region's actions can affect another region's supplies. Statewide planning involves assessing trends in each region's water demand and quantifying the cumulative effects of each region's demand and use patterns on statewide supplies. It basically parallels planning at the local and regional levels. By working through a statewide planning process, the magnitude of both intra- and inter-regional effects can be analyzed. However, in a number of circumstances, measures that would be taken to manage demand, to increase supplies, or to improve water service reliability are local decisions. These decisions must assess and compare the cost of increased water reliability against the economic, environmental, and social costs of potential shortages.

In the short term, those areas of California that rely on the Sacramento-San Joaquin Delta for all or a portion of their surface water face an unreliable supply due to the evolving protections for aquatic species and water quality. At the same time, California's water supply infrastructure is severely limited in its capacity to transfer marketed water through the Delta due to those same operating constraints. Until solutions to complex Delta problems are identified and put in place and demand management and supply augmentation options are implemented, some water-dependent regions will experience imported water shortfalls. Such limitations of surface water deliveries will continue to exacerbate groundwater overdraft in the Tulare Lake region because groundwater is used to replace much of the shortfall in surface water. In addition, water transfers within these areas have and will become more common as farmers seek to minimize water supply effects on their operations. In urban areas, water conservation and water recycling will be accelerated to help offset short-term water needs. Proposition 50, also known as "Water Security, Clean

Drinking Water, Coastal and Beach Protection Act of 2002," provides a mechanism for funding projects to augment systems and supplies, optimize delivery systems, use recycled water, and increase water management efficiency.

Distinct environmental water needs exist for each of the four major watersheds in the Tulare Lake Hydrologic Region that encompass the river systems of the Kings, Kaweah, Tule and Kern. There has been significant activity on both the Kings and Kern Rivers to restore flows for habitat as well as recreation. Modification to outlet structures and timing of releases on the Kings River provide cooler water temperatures to protect the resident trout populations. Gravel augmentation is also carried out to provide spawning habitat. The Kern County Water Agency has implemented a successful and innovative program of delivering water supplies down the river through the City of Bakersfield, thus providing water for instream uses which can later be extracted farther downstream through the use of wells. Environmental water supplies on the Kaweah and Tule rivers are being modified due to the mitigation requirements tied to reservoir enlargement projects on both systems.

Groundwater pumping, a major source of supply in the Tulare Lake region, continues to increase in response to growing urban and agricultural demands. If groundwater extraction continues to be used to offset anticipated but unmet surface water imports, it will have negative consequences. One such effect of long-term groundwater overdraft is land subsidence, which also results in a reduction of aquifer storage space. This has already caused some damage to canals, utilities, pipelines, and roads in the region. In an effort to slow this condition, many water agencies have adopted groundwater replenishment programs by taking advantage of excess water supplies available in wet years, incidental deep percolation, and seepage from unlined canals.

On the region's west side, salinity, sulfate, boron, chloride, and selenium limit the uses of groundwater. Salinity is the primary water quality factor affecting use of groundwater for irrigation and native habitat. Where groundwater quality is marginal to unusable for agriculture, farmers use good quality surface water to irrigate crops or blend higher quality surface water with poor quality groundwater to create a larger supply. The inefficiency of some crop irrigation systems can increase percolation of irrigation water into the shallow unconfined aquifers, causing drainage problems and degrading groundwater quality. This marginal to poor quality groundwater has mounded up to reach crop root zones in this area and is threatening the viability of agriculture there.

Agricultural runoff and drainage are also the main sources of nitrate, pesticides, and selenium that endanger groundwater and surface water beneficial uses. The basin also has a relatively large concentration of dairies that contribute microbes, salinity, and nutrients to both surface water and groundwater. Nitrate has contaminated more than 400 square miles of groundwater in the Tulare Lake Basin. In addition, oilfield waste has impacted water quality. According to the Regional Water Quality Control Board's basin plan, there are more than 800 oilfield waste dischargers, of which 250 are regulated under waste discharge requirements.

Naturally occurring arsenic as well as pesticides and industrial chemicals have contaminated some groundwater supplies that are used for domestic water in the region. For example, the lone well that provides water for city of Alpaugh's 760 residents (40 percent of whom are defined as living at poverty levels) contains unsafe levels of naturally occurring arsenic. By 2006, new federal and State rules will force more than 50 central San Joaquin Valley communities, including Hanford, Pixley, and Tranquility, to cut arsenic levels to one-fifth the current allowable levels. The contamination of 40 wells in Fresno due to high levels of dibromochloropropane (DBCP), trichloroethylene (TCE), and other organic compounds resulted in the installation of activated charcoal filtration systems to remove these contaminants.

The quality of local surface water from the Kings River and the San Joaquin River (diverted south through the Friant-Kern Canal) is generally considered excellent for irrigation, municipal, and industrial uses. However the Central Valley Regional Water Quality Control Board has specifically identified salinity in the lower Kings River as a water quality priority in its 2002 Triennial Review. On the west side of the region, the California Department of Water Resources (DWR) has sought solutions to the flooding on the Arroyo Pasajero, which threatens the California Aqueduct. The aqueduct, which forms a barrier to arroyo floodwaters and sediment flow, is at risk of failure during major rainstorms in the watershed. Also, the naturally occurring asbestos in the arroyo sediments that enter the aqueduct during floods has raised questions of possible health risks. Both Panoche and Silver creeks contribute large sediment loads to the valley floor, and Panoche Creek also contains elevated levels of selenium.

For many years, portions of the Tulare Lake region have experienced significant drainage problems. The need for proper drainage of agricultural return flows has long been recognized by federal and State agencies. Planning for drainage facilities to serve the San Joaquin Valley began in the mid-1950s. The

poorly drained area is concentrated along the western side of the San Joaquin Valley from Kern County north into the San Joaquin River Hydrologic Region. Although the San Joaquin Valley has some of the most productive agricultural lands in the world, much of the west side of the valley is plagued by poor subsurface drainage that adversely effects crop productivity. Between 1977 and 1991, the area affected by saline shallow groundwater on the west side doubled to about 750,000 acres. At present, a substantial portion of the valley, about 2.5 million acres, is threatened by saline shallow groundwater resulting from the lack of proper drainage.

In addition, drainage water is sometimes contaminated with naturally occurring, but elevated, levels of selenium, boron, and other toxic trace elements that threaten the water quality, environment, and fish and wildlife. Water planners had originally envisioned a master surface water drain to remove this poor quality water, but that proposal was never implemented. The U.S. Bureau of Reclamation has an obligation to provide agricultural drainage service to farm lands served by the CVP on the west side of the valley. To convey this sometimes contaminated drainwater more directly to the San Joaquin River and away from the sensitive San Luis National Wildlife Refuge Complex, a portion of the San Luis Drain was reopened in September 1996 as part of the Grassland Bypass Project. The San Luis Drain was modified to allow drainage through six miles of Mud Slough, a natural waterway that passes through the San Luis National Wildlife Refuge Complex and a section of the North Grassland Wildlife Area.

Monitoring the quality of San Joaquin Valley agricultural drainage water began in 1959 as a cooperative agreement between the DWR and the University of California. In 1984, the San Joaquin Valley Drainage Program was established as a joint federal and State effort to investigate drainage and drainage-related problems and identify possible solutions. In September 1990 the San Joaquin Valley Drainage Program summarized its findings and presented a plan to manage drainage problems in a report titled "A Management Plan For Agricultural Subsurface Drainage and Related Problems in the Westside San Joaquin Valley." In December 1991 several federal and State agencies signed a memorandum of understanding and released an implementation strategy titled "The San Joaquin Valley Drainage Implementation Program." The purpose of the 1991 MOU and its strategy document was to coordinate various programs in implementing the 1990 recommendations.

In 1997 member agencies of the San Joaquin Valley Drainage

Implementation Program and the University of California initiated a plan to review and evaluate the 1990 Plan and update its recommendations. Eventually, the San Joaquin Valley Drainage Authority, which includes districts in the Grassland, Westlands, and Tulare subareas, was formed to develop a long-term solution for drainage problems in the valley, which could include out-of-valley disposal. Studies continue in pursuit of cost-effective ways to dispose of the drainage water.

In 2002 the U.S. Bureau of Reclamation released a new San Luis report, which declared that an “in-Valley” solution to the drainage problem on the valley’s west side should be implemented. The proposed alternative contains features that include a drainwater collection system, regional drainwater reuse facilities, selenium treatment, reverse osmosis treatment for the Northerly Area, and evaporation ponds for disposal of accumulated salts.

Also in 2002 the Westlands Water District and the United States reached a settlement agreement regarding the drainage of lands that the federal government was legally obligated to provide to west side farmers. Under this agreement the federal government would buy the poorest drained agricultural lands from farmers and then remove those lands from agricultural production. As a result of this agreement, the number of acres requiring drainage service in the San Luis Unit will initially be reduced by retiring about 33,000 acres, part of a long-term plan that may eventually retire up to 200,000 acres.

Accomplishments

Many water districts in recent years have actively been working to improve agricultural water delivery and use efficiencies. About 14 individual water districts encompassing more than 1.3 million acres have become signatories to the Agricultural Water Management Council and have prepared Agricultural Water Management Plans. In addition, many water districts are working with individual growers to improve on-farm irrigation water management systems and efficiency. These activities include providing irrigation scheduling information, assistance in obtaining low interest loans, water trading to improve delivery efficiency, delivery augmentation and irrigation system evaluations.

On the western side of the San Joaquin Valley, particularly in Fresno and Kings counties, farmers are using more sprinkler irrigation and less flood, basin, or furrow irrigation as a means to reduce excess runoff. This change in water use methods also reduces incidental deep percolation to groundwater, which is beneficial for areas that have problems with

high water tables. In addition, improved management of the remaining farm lands that use furrow and basin irrigation is resulting in the reduction of applied water. By 1998, less than half of the agricultural land in this region still used the flood irrigation method.

Many farmers use sprinklers and drip irrigation, especially on truck crops where small applications of water early in the growing season are very beneficial. The amount of water applied during the pre-irrigation of cotton and other crops has been significantly lowered via increased use of sprinklers. Buried drip irrigation systems have been increasing in acreage, as the proper equipment and designs are proven successful. Currently, almost all new plantings and replanting of orchards and vineyards are installing drip or micro-sprinkler irrigation systems and many older plantings are being converted from furrow or basin systems, where conditions are favorable for success. As trees and vines age, their yields decrease to a point where returns are no longer profitable, and orchards are then replanted. Eventually nearly all trees and vines in the region are likely to be irrigated with micro-irrigation systems, as long as conditions are favorable to this conversion.

DWR conducted a survey of irrigation methods being used to irrigate crops in Kern County in conjunction with its summer land use surveys performed in 1984 and 1998, as shown in Table 8-2. The results indicate that the adoption of micro-irrigation systems has increased dramatically in all plantings of truck and permanent crops over this period. This transition to the more efficient drip and micro-sprinkler systems has greatly improved agricultural water use efficiency and thus reduced the amount of applied water that is needed.

In general, management of all irrigation systems, including non-pressurized irrigation systems, such as furrow and basin, has been improving. Economic factors, such as the need to keep overall production costs down, are a primary reason for increasing farm water use efficiency. These agricultural economic considerations include higher production costs, higher utility rates, and low market prices for crops sold. Inconsistent year to year contract deliveries from the CVP and SWP have also motivated farmers to improve efficiency. Farmers are using a wider availability of crop irrigation scheduling information and soil moisture monitoring programs to respond to these cost concerns. On-going and expanded public outreach and training efforts by the UC Cooperative Extension, irrigation districts, and other agencies has made helped make these improvements possible.

Table 8-2 Percentage of acreage of each crop category by irrigation method used – Kern County

	1984	1998	1984	1998	1984	1998
	SURFACE		SPRINKLER		MIRCRO	
GRAIN	52.1	46.1	47.9	53.9	0.0	0.0
FIELD CROPS	63.9	77.2	36.1	22.8	0.0	0.0
ALFALFA	77.2	88.3	22.8	11.7	0.0	0.0
PASTURE	76.9	81.7	23.1	18.3	0.0	0.0
TRUCK CROPS	17.4	24.9	82.6	70.5	0.0	4.6
DECIDUOUS ORCHARD	41.9	29.9	27.2	6.1	30.9	64.0
SUBTROPICAL	13.8	2.8	23.4	0.6	62.8	96.6
VINEYARD	59.2	36.1	15.7	1.8	25.2	62.1

Efforts to improve water use efficiency in the urban sector began earnestly during the last six-year drought, which extended from 1987 through 1992. The California Urban Water Conservation Council was created in 1991 with the development and signing of the "Memorandum of Understanding Regarding Urban Water Conservation in California." The CUWCC is composed of urban water agencies, public interest organizations, government agencies, and private entities. Together these organizations work to promote efficient urban water use statewide. Many water and utility companies throughout the state offer financial and technical assistance programs that specifically help residential customers with limited finances to implement water and energy efficiency programs in their homes.

Throughout the State, Urban Water Management Plans are now required under the provisions of the California Urban Water Management Planning Act. These plans must be adopted and submitted to the State every five years by all water suppliers that provide water for municipal purposes to more than 3,000 customers. In general, these plans must describe an agency's current sources of water supply and the municipal demands being served, provide estimates of future urban demands, and describe the proposed management methods and water supply sources that will be developed to meet the future needs. Water agencies and municipalities in the Tulare Lake region that have submitted urban water management plans include West Kern Water District, North of the River Municipal Water District, East Niles Community Services District, City of Clovis, City of Dinuba, McAllister Ranch, Tejon-Castaic Water District, City of Wasco, Oildale Mutual Water Company, Vaughn Water Company, City of Bakersfield, City of Corcoran, City of Lemoore, City of Reedley, City of Hanford, Kern County Water Agency, and the City of Sanger. Nine of the above agencies now have completed urban water management plans.

Regarding groundwater, the Groundwater Management Act of 1992, AB 3030 (California Water Code Section 10750 et seq.) allows certain defined existing local agencies to develop groundwater management plans. Groundwater basins are explained and defined in "California's Groundwater" (DWR Bulletin 118, Update 2003). Before the passage of AB 3030, the California Water Code had been amended by AB 255 in 1991 which allowed local agencies overlying critically overdrafted groundwater basins to develop groundwater management plans. Six water agencies in the Tulare Lake region prepared groundwater management plans under AB 255 laws. Following AB 3030 legislation, 26 additional groundwater management plans have been adopted in this region. In 2002, SB 1938 amended existing law related to groundwater management by local agencies. This law now requires any public agency that applies for State funds for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan that contains more specific procedures and plan components.

Cities and counties in the region are continually introducing new water system technology to solve problems, reduce costs, and improve system operations as part of efforts to maintain, expand, and update their municipal water systems. After years of violating state drinking water standards for taste and smell, the city of Mendota, in western Fresno County, is in the process of implementing major water system improvements. Three new wells east of the city have been constructed, each with the capacity to pump up to 1,500 gallons per minute. This new groundwater supply is transported to the city's treatment facility via a 20-inch pipeline, where a new filtering tank has been added to improve the water purification system.

The California Revolving Fund program disburses low interest loans to address water quality problems associated with discharges from wastewater and water reclamation facilities, as well as from nonpoint source discharges and for estuary enhancement. This policy was written to implement the 1987 Amendments to the Federal Clean Water Act, which created the State Revolving Fund (SRF) Loan Program. In the Tulare Lake Region recent program participants include (1) the town of Alpaugh with a treatment and collection system, (2) the City of Fresno's treatment plant expansion, (3) the County of Kern's Rexland Acres community sewer collection and transmission system, and (4) the Fresno Metropolitan Flood Control District's storm water quality management program.

The City of Clovis received AB 303 funding for a proposed project that will include (1) compiling groundwater recharge basin site characteristics to increase recharge capabilities, (2) constructing groundwater monitoring wells at recharge facilities to better monitor percolation and movement, and (3) creating a Ground Water Information System (data management system) to provide a comprehensive and organized data base for improved groundwater data accessibility and maintenance.

In Kern County, the Kern Water Bank groundwater program will receive Proposition 13 funding to increase the recovery capacity of the Kern Water Bank. The Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program administered by the Kern County Water Agency will receive Proposition 13 funding to provide additional opportunities for Kern County facilities to capture and transport high-flow water supplies and may provide water for ecosystem restoration and the Environmental Water Account.

Another project receiving Proposition 13 funding is the Kern Water Bank River Area Recharge and Recovery Project that would allow the Kern Water Bank Authority to provide as much as 50,000 acre-feet per year of additional water recovery capability. In years when recovery needs are less than recovery capacity, water could be recovered for the Environmental Water Account or other ecosystem restoration needs.

The North Kern Groundwater Storage Project will take advantage of wet-year high flows and store them in the groundwater aquifer. This may reduce demands on water supplies from the Delta in dry years.

The Westlands Water District received AB 303 funding to find more water, including potential conjunctive use opportunities. The investigation included three deep soil-boring and monitoring wells installed by DWR to evaluate the storage, water quality, and extraction potential of the groundwater aquifer. AB 303

also paid for the installation of 35 shallow borings to evaluate the percolation potential of the uppermost soil sediments. The study was completed in 2002 and recommended the area where Arroyo Pasaajero intersects with Interstate 5 as a site for conjunctive use groundwater application.

Within the past several years, Broadview Water District announced that landowners had decided to sell the district due to the increasing costs of water production and the additional water system costs associated with the district's drainage and salinity problems. In 2003 the Pajaro Valley Water Management Agency and Broadview Water District began negotiating the sale. Pajaro Valley WMA had prepared the necessary paperwork and completed the required studies, but negotiations never culminated in an agreement that was acceptable to both parties. At about this time, Westlands Water District, which shares part of its northern district boundary with Broadview, began negotiations with the Broadview Water District. Westlands recently announced that negotiations had been completed to purchase the Broadview Water District and that the acquisition would encompass all the Broadview lands and include the Broadview Water District's 27,000 acre-foot CVP water service contract. This sales/purchase agreement is being circulated among Broadview landowners for their approval, and the transaction is expected to be completed in 2005. District staff has also met with Fresno County Local Agency Formation Commission to discuss annexing the Broadview lands into Westlands.

For several years Westlands WD has been attempting to "augment" its water supplies by selling agricultural lands that have severe drainage problems and then using the water entitlements retained from those lands to firm up the water entitlements to the remaining irrigated lands within the district. The impending purchase of Broadview Water District with its CVP water entitlement is another example of this ongoing process.

Among other regional programs, the U.S. Natural Resources Conservation Service has been promoting agricultural programs in western Fresno County that:

- (1) reduce the amount of salts leached to ground water and improve shallow, saline water table conditions with improved irrigation water management.
- (2) improve the distribution and management of livestock to reduce erosion using prescribed grazing, fencing, and improved watering facilities for livestock.
- (3) reduce soil salinity in the crop root zone to improve cropland productivity with improved irrigation water management and soil salinity management.
- (4) reduce the amount of airborne particulates with adjusted

timing of agricultural operations, vegetating turn areas, and avoiding tracking soil onto the county roads.

- (5) reduce sheet and rill erosion on rangeland through improved livestock distribution and production of forage.

The Lake Kaweah Enlargement Project proposes to raise the Lake Kaweah spillway by 21 feet and increase the lake's water storage capacity by 43,000 acre-feet to 183,000 acre-feet, or 28 percent. Still a small lake in comparison to others in California, the enlargement project will increase flood protection to downstream communities on the Kaweah Delta river system, especially near Visalia. The dam's spillway crest, a U-shaped cut, is being raised with the installation of "fuse gates." These gates are like large concrete teeth that pop out like fuses if the lake should become so full. Once completed, farmers are expected to see immediate benefits because a larger lake will allow longer irrigation periods during the summer months. Additionally, the Tulare Lake bottom lands are less likely to be inundated with flood flows that occasionally interrupt farming operations. Recreational use will also be enhanced because even in winter, when lake levels are low, it will be large enough for boating. The federal government is funding more than half the cost of the \$33 million project, the State Reclamation Board is providing \$10.1 million, and the local agencies are providing the remaining \$5.4 million.

The Coordinated Resource Management and Planning (CRMP) groups in the Tulare Lake region include the Panoche/Silver Creek CRMP, the Stewards of the Arroyo Pasajero Watershed CRMP, and the Cantua/Salt Creek Watersheds CRMP. The general purpose of these groups is to promote watershed health throughout the western Fresno County foothills. The primary concerns in these watersheds are flooding, erosion, sediment transport, and the quality of water entering into the San Joaquin River and the California Aqueduct. Some of the water management strategies that have been developed to address these problems include streamflow and water quality monitoring programs, revegetation of embankments, and implementation of watershed best management practices.

As part of the Kern County Water Agency's Kern River Restoration and Water Supply Improvement Program, the Kern River Parkway will include a new 40-acre multipurpose recharge lake and recreation area with a permanent 10-acre recharge lake and adjoining playing field that will be surrounded by grassy slopes and tree-shaded seating areas. During extremely wet water years, these open 25-acre fields will be flooded and used for groundwater recharge in the spring. There will also be a new access route to the existing Kern River north bank equestrian trail from the future Jewetta Avenue extension.

Relationship with Other Regions

The Tulare Lake region receives CVP water from the San Joaquin River region via the Friant-Kern Canal and imported water from the Sacramento-San Joaquin Delta via the SWP California Aqueduct and the CVP San Luis and Delta-Mendota canals. The regional map in Figure 8-1 identifies the amounts of water imports and exports for recent years 1998, 2000, and 2001. The economic health of the region heavily depends on the availability of imported surface water to meet current and future needs. Several water districts within the Tulare Lake region have developed groundwater storage and recovery programs that benefit water districts outside of the region. Groundwater overdraft has created sufficient dewatered storage space to store water for local uses and for extraction and exchange or delivery to other agencies. Revenues generated by these storage and recovery programs have helped finance additional conveyance infrastructure to move surface water to areas that were previously served with groundwater. This type of conjunctive use activity ultimately helps relieve overdraft, while providing additional water supplies to agencies outside of the region.

Looking to the Future

Major water agencies and counties within the Tulare Lake region have been proactive for many years in all facets of water use and supply planning (see Box 8-1 Ongoing Planning Activities). The efficiency of water diversions from local rivers and streams is continually being optimized to meet agricultural and urban purposes. In addition, when it became apparent that the groundwater supply was not sustainable for meeting all future water demands, water agencies worked with the CVP and SWP to find ways to improve delivery capabilities.

The predominantly agricultural economy is now adapting to share water resources with the rapidly growing urban economy. New projects have been identified as necessary to better manage the local water supplies, as well as to adhere to more stringent water quality standards and environmental regulations.

Regional Planning

An important component of California's ability to meet future water needs involves the voluntary transfer of water from one user to another. In recent years, programs and proposals that involve water transfers have become very active in the Tulare Lake region and adjacent areas. Water districts have also made significant progress in the development and expansion of groundwater banking agreements and conjunctive

use programs, which facilitate the storage and movement of water to where it is needed.

The San Joaquin Valley Water Coalition is one example of several regional groups that facilitate the discussion of common issues related to water supply, water quality, and water management to ensure the reliable distribution of water. Some of the factors that are commonly considered in these regional planning efforts include:

- Population growth, impacts, and resulting water needs
- Groundwater overdraft and associated problems
- Preservation of prime agricultural lands
- Reliability of water supplies in foothill and mountain communities
- Reliability of water supplies for fish, refuges, and the environment
- Potential water transfers and exchanges and their effects
- Groundwater banking programs
- Groundwater quality issues, particularly for drinking and municipal use

Several examples of recent projects that have evolved through the use of regional planning approaches are mentioned below.

Pond-Poso Improvement District Project Enhancements. The Pond-Poso Improvement District is working to improve the groundwater resource in north-central Kern County. The district recently qualified for Proposition 204 funds. A primary goal is to encourage local groundwater users to begin using surface water whenever available instead of groundwater, which will help to stabilize the groundwater basin. The project is being completed by the Semitropic Water Storage District.

Pioneer Groundwater Recharge and Recovery Project. Funding obtained from Proposition 204 will be used to enhance the Kern County Water Agency's Pioneer Project. This project will develop

methods to maximize recovery of recharged groundwater, to increase the water supply available to the program participants. The project has the potential to reduce dry-year demands for surface water from the Sacramento-San Joaquin

Pond - Shafter - Wasco Irrigation and Water Use Efficiency. This effort is targeting agricultural irrigation in Kern County. The project's goals are to (1) implement a Total Farm Management Program for the San Joaquin Valley portion of Kern County; (2) reduce PM-10 levels on 50 percent of the permanent crops harvested in the valley; (3) reduce agricultural water use by 15 percent over the next five years through changes to irrigation systems and irrigation management; (4) increase wildlife habitat by 30 percent over the next five years; and (5) educate local growers about new or proven techniques in water, air, nutrient, and pesticide management. The Pond-Shafter-Wasco Resource Conservation District and the Natural Resources Conservation Service are leading this project.

Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program. Proposition 13 funding will be used to provide additional opportunities for Kern County to develop water supplies for local uses, increase opportunities for ecosystem restoration, and increase sales to the Environmental Water Account. Kern County Water Agency has received the funding to develop this program.

White Wolf Basin Groundwater Banking Project. The White Wolf Basin is a small, somewhat isolated, groundwater basin in the southeastern corner of Kern County. The Wheeler Ridge-Maricopa Water Storage District is studying groundwater banking using this aquifer. Surface water from the California Aqueduct would be imported for use in groundwater storage. Recovered water could then be conveyed back to the aqueduct, or introduced into the district's distribution system and exchanged for SWP water. Pilot wells are being drilled in order to better understand the geology of the groundwater basin.

South Valley Water Management Program. The southern

Box 8-1 Ongoing Planning Activities

- Kern County Water Agency Conjunctive Management Program
- Water Agency Exchanges and Transfers
- Kern County Water Agency EWA Sales
- Optimization of Water Conveyance Systems
- Inter-regional Water Storage, Drought Supply Agreements

end of the San Joaquin Valley has water conveyance facilities that are interconnected, especially in Kern County. During wet years water can become available for short durations from any of a number of sources, including the San Joaquin River, Kings River, and Kern River. The Kern County Water Agency and several south valley water districts are evaluating possible ways to coordinate supplies and deliveries in order to take full advantage of these wet year supplies.

Rosedale-Rio Bravo Water Storage District Banking Program.

The Rosedale-Rio Bravo Water Storage District (RRB) is developing a groundwater banking project with a maximum storage of 500,000 acre-feet. Recharge basins and recovery wells are being constructed. Generally, RRB will store water for other entities in wet years by offering a 2-for-1 exchange proposal. In drier years this water would be returned, either by exchange delivery of RRB's SWP or Kern River water, or by pumping from wells if there is insufficient exchange capacity.

Kern Delta Water District/Metropolitan Water District Joint Banking Project.

Kern Delta Water District is developing a groundwater banking partnership with the Metropolitan Water District of Southern California. MWD will store water in the groundwater basin underlying the Kern Delta Water District in wet years and recover the water during drier years. The project is similar in concept to a separate joint Arvin-Edison/MWD Program. The program contemplates storing a maximum of 250,000 acre-feet of water for MWD.

Other long-term programs and activities that may be considered for the Tulare Lake region include:

- Methods to increase agricultural water use efficiency
- Methods to increase urban water use efficiency
- Water conservation activities
- Agricultural land retirement
- Temporary fallowing of crop lands
- SWP water supply augmentation concepts
- CVP water supply augmentation proposals
- Mid-Valley Canal as a new surface water facility
- Demand reduction strategies
- Short-term water transfers
- Use of "gray water" for approved purposes
- Water recycling proposals
- Local conjunctive use
- Groundwater reclamation efforts
- Treatment and reuse of brackish agricultural drainage water

Water Portfolios for Water Years 1998, 2000, and 2001

Detailed information about actual water supplies and water uses (called "water portfolios") for water years 1998, 2000, and 2001 is presented in tables 8-3 and 8-4 and figures 8-4 and 8-5.

Water Year 1998

California weather and precipitation were significantly affected by an El Nino weather event during the winter of 1997-98. The last prior El Nino period occurred in 1991-92. Wet El Nino storms did not begin earnestly until January 1998, after which storm impacts resulted in damage to a number of crops. Of California's 58 counties, 42 were declared major disaster areas during that year.

The wet weather damaged some winter and spring crops and delayed the planting and development of some summer season crops. Consumers felt the impacts from the resulting higher supermarket prices for California vegetables. Producers had difficulty getting into their soggy fields in the spring, delaying normal farming practices, such as spraying, pruning, and tying vines. The wet weather also reduced both the quality and volume of many crops harvested during this year. However for late-developing crops such as cotton, raisins, and table grapes, the fall weather produced clear skies and good temperatures, which allowed the majority of these late-season crops to be harvested without weather problems.

Watershed runoff was well above normal, as unimpaired runoff from both the San Joaquin and Kings rivers was about 170 percent of average, the Kaweah River was 196 percent of normal, and the Kern River runoff was 224 percent of average.

The total amount of acreage irrigated in this region varies in direct relation to the amount of surface water available from local and imported sources in any particular year. The 1998 total irrigated acreage was 3.2 million acres, based on abundant water supplies. The trends in crop acreage pointed towards increased acreage of higher value commodities such as fruits, tree nuts and vegetables; while the acreage of field crops was declining. Acreage planted in wine grapes was rapidly increasing, and the acreage planted in almond trees also continued to increase at a steady rate.

The dairy industry continued its growth in 1998, particularly in Tulare County, which is now the top milk-producing county in the nation. Alfalfa acreage in the Tulare Lake region exceeded 360,000 acres in 1998, up from 279,600 acres reported in

Table 8-3 Tulare Lake Hydrologic Region Water Use and Distribution of Dedicated supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	16.1			19.2			19.8		
Commercial	37.5			44.6			46.4		
Industrial	53.5			63.8			66.4		
Energy Production	0.0			0.0			0.0		
Residential - Interior	208.6			248.8			259.0		
Residential - Exterior	219.4			261.4			272.5		
Evapotranspiration of Applied Water		187.1	187.1		223.3	223.3		232.5	232.5
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	10.6			12.8			13.3		
Conveyance Evaporation & ETAW		10.6	10.6		12.8	12.8		13.3	13.3
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.7			2.9			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	546.4	197.7	197.7	653.5	236.1	236.1	677.4	245.8	245.8
Agriculture									
On-Farm Applied Water	7,006.6			9,677.3			9,933.6		
Evapotranspiration of Applied Water		5,181.0	5,181.0		7,162.0	7,162.0		7,320.4	7,320.4
E&ET and Deep Perc to Salt Sink		457.3	457.3		457.3	457.3		457.8	457.8
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	735.4			797.0			590.5		
Conveyance Evaporation & ETAW		415.3	415.3		472.5	472.5		380.0	380.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	824.8			328.3			42.6		
GW Recharge Evap + Evapotranspiration		18.0	18.0		13.0	13.0		1.4	1.4
Total Agricultural Use	8,566.8	6,071.6	6,071.6	10,802.6	8,104.8	8,104.8	10,566.7	8,159.6	8,159.6
Environmental									
Instream									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	3,205.0			1,331.1			964.1		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	62.9			73.7			76.3		
Evapotranspiration of Applied Water		32.7	32.7		41.4	41.4		38.3	38.3
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		3.1	0.0		2.5	0.0		2.5	0.5
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	62.9	35.8	32.7	73.7	43.9	41.4	76.3	40.8	38.8
Total Environmental Use	3,267.9	35.8	32.7	1,404.8	43.9	41.4	1,040.4	40.8	38.8
TOTAL USE AND OUTFLOW	12,381.1	6,305.1	6,302.0	12,860.9	8,384.8	8,382.3	12,284.5	8,446.2	8,444.2
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	3,621.8	3,621.8	3,620.1	2,397.0	2,397.0	2,396.1	1,698.0	1,698.0	1,697.2
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	1,811.3	1,811.3	1,810.4	2,280.2	2,280.2	2,279.3	1,787.9	1,787.9	1,787.1
Other Federal Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWP Deliveries	1,035.0	1,035.0	1,034.5	1,915.2	1,915.2	1,914.5	849.3	849.3	848.9
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	-163.0	-163.0	-163.0	1,792.4	1,792.4	1,792.4	4,111.0	4,111.0	4,111.0
Deep Percolation of Surface and GW	2,871.0			3,145.0			2,874.2		
Reuse/Recycle									
Reuse Surface Water	3,205.0			1,331.1			964.1		
Recycled Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLIES	12,381.1	6,305.1	6,302.0	12,860.9	8,384.8	8,382.3	12,284.5	8,446.2	8,444.2
Balance = Use - Supplies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1995. Corn acreage rose even faster than alfalfa, exceeding 257,000 acres in the region in 1998, which was driven by the increasing demand for cattle feed by the dairy industry.

Cotton acreage was substantially lower due primarily to the El Niño weather, decreasing to 655,400 acres (35 percent less than year 1995). Growers continued the trend of converting field crop land to almond/pistachio orchards in an effort to generate better long-term profits. The combined almond/pistachio acreage of 245,700 acres was 32 percent higher than the acreage reported in 1995.

The El Niño storms provided a significant amount of rainfall on agricultural fields, filling soil profiles, and reducing the early season evapotranspiration of applied water (ETAW). Consequently, less applied water was needed for irrigation compared to most normal years. Estimated total agricultural on-farm applied water was 7 million acre-feet for the Tulare Lake region; total agricultural water use was 8.6 million acre-feet (or 69 percent of all uses). The total agricultural ETAW in 1998 in the region was 5.2 million acre-feet. The regional average unit ETAW was 1.6 acre-feet per acre. Individual crop ETAW amounts vary due to differences in rainfall, growing season, soil texture, and rooting depths.

Total urban applied water use, including residential, commercial, industrial, and landscape, in the region was 546,400 acre-feet. Urban water use accounted for only about 5 percent of the total applied water in this hydrologic region. The total population of the region in 1998 was 1,816,440. Total urban ETAW for the year was about 187,100 acre-feet, and the regional average per capita water use was about 268 gallons per day.

Total environmental demand for instream flows, wild and scenic rivers, and waterfowl refuges was about 3.3 million acre-feet. This accounted for 26 percent of total uses. This includes water that is reserved for instream and wild and scenic river flows but can later be diverted as a supply by other downstream users. Refuge water uses, which are supplies applied directly onto wildlife refuges, accounted for 62,900 acre-feet.

Total supplies, including local and imported CVP and SWP surface water, groundwater, and reuse, amounted to 12.4 million acre-feet, as detailed in Table 8-3.

Water Year 2000

The weather for water year 1999-2000 in the Tulare Lake Region was very close to the long-term average. Rainfall was slightly below normal in the southern areas of the region,

where Bakersfield received 81 percent of average. Precipitation was somewhat higher than normal in the northern areas of this region, where Fresno received 120 percent of average. Watershed runoff was about 101 percent of average from both the San Joaquin and Kings rivers, 87 percent of average from the Kaweah River and about 70 percent of average from the Kern River.

Total irrigated crop acreage within the region was 3.2 million acres, which was virtually unchanged from 1998. However, the acreage of some individual crops did change significantly from 1998. The largest change in crop acreage was for cotton, which increased 10.7 percent to 725,300 acres in 2000. The combined almond and pistachio acreage of 257,000 was 11,200 acres, or 4.6 percent higher than in 1998. Corn acreage, primarily for silage, declined 10 percent during this year.

The total agricultural on-farm applied water in 2000 for the Tulare Lake region was 9.7 million acre-feet, a significant 38 percent increase over 1998. This large difference illustrates the degree to which wet and cool conditions can alter the irrigation water demand and crop acreage grown. 1998 was a very wet and cool year (low evaporative demand), which reduced irrigation demand dramatically. In contrast the total agricultural water use for 2000 was 10.8 million acre-feet (84 percent of all uses) and 26 percent more than 1998. The regional average agricultural on-farm unit applied water was about 3.4 acre-feet per acre.

The total agricultural ETAW in the region was about 7.2 million acre-feet, or 38 percent higher than that of 1998. The regional average unit ETAW was 2.2 acre-feet per acre.

The dairy industry continued its strong growth in year 2000. New records were set for the number of milk cows and milk production. In 2000, California led the nation in total milk production with a record 32.2 billion pounds, representing a 6 percent increase from the previous year. The Tulare Lake region was responsible for a large part of this increase in the number of dairies and cows.

In 2000, total urban applied water for the region was 653,500 acre-feet, which was about 20 percent higher than the total applied water in 1998. Urban water use accounted for more than 5 percent of the total applied water in the region. Total population in 2000 in the Tulare Lake region climbed to 1,884,650, an increase of 3.8 percent over the 1998 population. Average per capita water use was also much higher

than 1998, at 310 gallons per day. Total urban ETAW for the year was about 223,300 acre-feet, an increase of 19 percent from 1998.

Environmental demand for instream flows, wild and scenic rivers, and refuges for the region was about 1.4 million acre-feet in year 2000, which is 57 percent less than 1998. This category accounted for 11 percent of total uses. Because the components of environmental water use are directly tied to streamflows, this category of use will always decline during normal to drier water years. Refuge supplies, which are supplies applied directly onto wildlife refuges, accounted for 73,700 acre-feet in 2000.

Total developed water supplies, including local and imported from the CVP and SWP surface water, groundwater, and reuse, amounted to about 12.9 million acre-feet, which is 4 percent more than in 1998.

Water Year 2001

The 2001 water year started out cooler than normal with cumulative rainfall below average through most of January. However, large-scale weather patterns changed significantly as February approached and a series of Pacific storms moved into the state, bringing regional precipitation totals closer to normal. Rainfall amounts were slightly less than average for the water year in the region with totals in both Fresno and Bakersfield about 93 percent of average.

Except for a thunderstorm in April that produced significant high wind, hail, and rainfall, crop development was generally normal throughout the remainder of the growing season. Less than normal precipitation in local watersheds resulted in below normal river runoff and below normal surface water supplies. Runoff from the San Joaquin, Kings, and Kaweah rivers was about 71 percent of average for each, while runoff from the Kern River was 54 percent of average.

Total irrigated agricultural acreage was 3.1 million acres, a decline of 9.6 percent (or 126,000 acres) from year 2000. The price for milk and cream commodities rose 14 percent in 2001 and pushed Tulare County to the top agricultural producing position in the nation, surpassing Fresno County, which had held the number-one position for many years. Cotton acreage was 639,400 acres, which was 85,900 fewer acres than in 2000, due primarily to the drop in price of the upland variety.

Sugar beet acreage continued its multiyear downward spiral to 15,100 acres, 47 percent less acreage than in 2000. The transition into wine grapes over the past several years leveled out as the market reached a point of saturation, and prices began to weaken. The acreage of raisin grapes dropped almost 20 percent in 2001 responding to the dramatic drop in price over the past two years. Raisin growers had received more than \$1,000 per ton in 1999 compared to about \$525 per ton in 2001. The almond/pistachio acreage continued the upward trend of previous years, increasing more than 10 percent in 2001.

The total agricultural on-farm applied water in 2001 for the Tulare Lake region was 9.9 million acre-feet, and total agricultural water use was 10.6 million acre-feet or 86 percent of all water uses. This amount is 23 percent more than 1998, but 2 percent less than year 2000. This resulted in an average unit rate of 3.4 acre-feet per acre. The total agricultural ETAW in the region was 7.3 million acre-feet, about 41 percent higher than 1998 and 2 percent higher than 2000.

The total urban applied water in 2001 for the region was 677,400 acre-feet, which was 24 percent higher than 1998 and 4 percent higher than 2000. Urban water use accounted for about 5.5 percent of the total applied water in the region. Total population in the region for 2001, was 1,921,915, an increase of 2 percent over the 2000 population and 5.7 percent higher than 1998. Average per capita water use was about 315 gallons per day, possibly due partly to the drier water supply conditions. Total urban ETAW for the year was about 232,500 acre-feet, an increase of 24 percent from 1998 and 4 percent from 2000.

Total environmental demand for instream flows, wild and scenic rivers, and refuges for the region was about 1.04 million acre-feet, 68 percent less than 1998 and 26 percent less than 2000. This accounted for about 8.5 percent of total uses. This includes water that is reserved for instream and wild and scenic river flow, which is generally much lower in below normal water years. Refuge supplies, which are applied directly onto wildlife refuges, accounted for 76,300 acre-feet.

Total water supplies, including local and imported CVP and SWP surface water, groundwater, and reuse, amounted to 12.3 million acre-feet, 1 percent less than 1998 and 4 percent less than 2000.

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